Claims 1-17 are pending in the application and are subject to restriction or election requirement.

Restriction to one of the following inventions is required under 35 U.S.C. §121:

Claims 1-8, drawn to an anode, classified in class 204, subclass 2[illegible].

Claims 9-17, drawn to a method of supplying electricity to an anode, classified in class 205, subclass 96.

The inventions are distinct because Inventions I and II are related as product and process of use. In the instant case the anode of the Group I claims can be used in processes other than the process of the Group II claims.

Applicants [illegible] claims 1-8 and have canceled claims 9-17. Applicants [illegible]

Applicants submit that the changes made herein are not new matter and are fully supported by the specification.

Applicants have amended the specification to correct matters of form. Applicants submit that the changes made herein are not new matter and are fully supported by the

Having addressed all issues set out in the office action, applicants respectfully request that the claims be allowed.

Respectfully submitted,

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APPENDIX

Please replace the paragraph at page 2, lines 3-13, with the following paragraph:

Deposition of a metal in electroplating is accomplished by providing an electric current to the seed layer and then exposing the seed layer to an electrolytic solution containing the metal to be deposited. One embodiment of an electroplating system that performs such metal deposition is depicted in FIG. 1. The device, known as a fountain plater 10, deposits metal on the seed layer 15 of a substrate 48. The fountain plater 10 includes an electrolyte cell 12 having [an upper opening 13,] a removable substrate support 14, and an anode 16 mounted to [and located near the base 447 of] the

to the anode 16. A negative pole 43 of the controller [40] 42 is electrically coupled to the seed layer 15 of the substrate via a plurality of contacts 256 disposed around the periphery of the electrolyte cell [near the upper opening 13].

Please replace the paragraph at page 2, lines 14-24, with the following paragraph:

The embodiment of contacts 256 depicted in FIG. 1 represents a simplified version in which [illegible] in a manner that permits the substrate to rotate within the electrolyte cell 12 while maintaining electric/current applied between the anode and the seed layer of the substrate. The electrolyte cell 12 comprises an anode base 90 and an upper container segment 92. The anode 16 is mounted to the anode base 90 by anode supports 94. A feed through 96 supplies electrical power to the anode and the electrical power is controlled by the controller [98] 42. The upper container segment 92 is sealably fastened to anode base 90 by nuts and bolts, screws, or other suitable removable devices to permit the repair and/or replacement of the anode 16 or other components.

Please replace the paragraph at page 2, lines 25-31, with the following paragraph:

The plurality of contacts 256 are configured to contact a plating surface 15 of the substrate that is immersed in an electrolyte solution contained in the electrolyte cell 12 to enable the deposition of metal on the substrate 48. The contacts 256 may take the form of a contact pin, a contact surface, or any known type of electrical contact. The contacts that are mounted about the periphery of [the] a contact ring [[illegible]] (not shown) are positioned to minimize irregularities of the electrical field applied to the seed layer formed on the plating surface 15 of substrate 48.

Please replace the paragraph at page 2, line 32, to page 3, line 2, with the following paragraph:

A substrate support 14 is pivotably mounted above the upper opening and is

14 is pivoted into the removed position, the attached substrate is removed upwardly from the electrolyte cell 12 [through the upper opening 13]. When the substrate support 14 is pivoted into the inserted position, the attached substrate is pivoted downward [through the upper opening 13] such that the plating surface 15 of the substrate 48 is immersed in electrolyte solution contained in the electrolyte cell. While in the immersed position, metal ions (typically copper or a copper alloy) contained in the electrolyte contained in the electrolyte cell 12 may be deposited on the substrate. The substrate support 14 keeps the substrate connected to the substrate support when desired (for example using vacuum chucking, etc.).

Please replace the paragraph at page 5, line 29 to page 6, line 2, with the following paragraph:

After considering the following description, those skilled in the art will clearly realize that the teachings of this invention can be readily utilized in metal ion deposition

applications, and more particularly to configure and provide anodes that can be selectively energized. In at least one aspect, a programmable anode is provided that improves the uniformity of the current density applied across a seed layer on a substrate (e.g.,wafer).

Please replace the paragraph at page 6, lines 9-16, with the following paragraph:

FIG. 2 is a cross sectional view of a fountain plater 10 having an electroplating cell 200 according to one embodiment of the invention. The electroplating cell 200 comprises the programmable anode [201] 202. The programmable anode [201] 202 is [illegible] independent control of the electric current passing through certain segments of the anode. The control of individual currents passing through respective individual segments of the anode provides variation of the electric field in the electrolyte solution contained in the electrolyte cell that can modify the metal deposition uniformity/non-uniformity across the substrate.

Please replace the paragraph at page 6, lines 17-29, with the following paragraph:

In the embodiment shown in FIG. 2, the anode [201] 202 comprises a plurality of anode segments 203a, 203b, 203c, and 203d, with each one of the anode segments formed from such materials as a high purity, oxygen free, copper (Cu). Each one of the plurality of anode segments 203a, 203b, 203c, and 203d are geometrically centered about an imaginary segment axis 208, and each anode segment has respective substantially coplanar upper segment surfaces 205a, 205b, 205c, and 205d. While four anode segments 203a, 203b, 203c, and 203d are shown in FIG. 2, any suitable number may be provided. Additionally, each one of the plurality of anode segments 203a, 203b, 203c, and 203d have respective lower substantially coplanar segment surfaces 207a, 207b, 207c, and 207d. Insulating connecting members 210 connect adjacent ones of the plurality of anode segments 207a, 207b, 207c, and 207d. The anode [201] 202

typically comprises a hydrophilic membrane [97] 87 as shown in the embodiment shown in FIG. 1 and described above, but is not depicted in FIG. 2 for simplicity of display.

Please replace the paragraph at page 6, line 30 to page 7, line 12, with the following paragraph:

The anode [201] 202 is configured as a modular assembly that provides for secure positioning and relatively easy replacement of the assembly and the anode segments. [insulating base] Anode support [270] 94 extends between, and is connected to, the anode base 90 and at least one anode segment of the anode 201. [illegible] support 94 [insulating base support 270] to the anode base 90 and the anode support 94 [insulating base support 270] to at least one of the anode segment 203a, 203b, 203c, or 203d. Insulative support members 210 physically support each anode segment 203a, 203b, 203c, and 203d relative to an adjacent anode segment (as shown in FIG. [illegible] 210 is formed of an insulative material that limits electric current passing between adjacent anode segments 203a, 203b, 203c, and 203d, such that each anode segment can be individually electrically biased to a separate potential. The [insulative base] anode support [270] 94 and the insulative support members 210 interact to maintain each of the anode segments 203a, 203b, 203c, and 203d fixed in position relative to the anode base 90 and the remainder of the [illegible] cell [201] 12 during [illegible], while keeping each one of the anode segments 203a, 203b, 203c, and 203d relatively insulated from one another and from the cell wall.

Please replace the paragraph at page 7, lines 13-30, with the following paragraphs:

Portions of the anodes [201] 202 are consumed by the electroplating process, resulting in the production of anode sludge. Portions of the anode being consumed results in the anode assuming an irregular shape and contour. For example, th height

of a worn anode is often inconsistent. Therefore, regular anode replacement is necessary to maintain uniform electric field generation within the electrolyte cell. When the anode [201] 202 does become irregularly shaped due to portions of the anode being consumed, or for other reasons, the anode [201] 202 should be replaced. To replace the anode, the upper container segment 92 is removed by lifting the upper container segment from the anode mount 90 after removing the fasteners that connect these two elements. The anode [201] 202 is then disconnected from the anode base 90, and the anode [201] 202 is removed as a modular unit. A replacement modular anode [201] 202 is then inserted and connected to the anode base 90. The upper container segment is then repositioned and fastened to the anode base, and will appear in the [illegible] FIG. 2. In another embodiment, the anode [201] 202 and the anode base 90 can be provided as a single modular unit. In this latter embodiment, another modular anode [201] 202/anode base 90 unit is provided to replace the anode base 90 connected to the consumed anode [201] 202. The upper container segment is then repositioned and fastened to the anode base in the position [illegible] FIG. 2.

Please replace the paragraph at page 7, line 31, to page 8, line 11, with the following paragraph:

Each one of the plurality of anode segments 203a, 203b, 203c, and 203d are electrically connected to the controller 254 by respective electrical contacts or feed-throughs 206a, 206b, 206c, and 206d that extend through the electrolyte cell 12 (preferably through the anode base 90 [447 of the electrolyte cell 12]). The feed-throughs 206a, 206b, 206c, and 206d are individually insulated by a coating such as an elastomeric or insulative plastic. The coating limits direct chemical or electrical reaction with the electrolyte solution, and especially those portions that extend within the electrolyte cell [200] 12. Anode support members [270] 94 rigidly and insulatively support at least one anode segment 203a, 203b, 203c, and 203d relative to the [base 447 of the] electrolyte cell [220] 12. Although the anode segments 203a, 203b, 203c, and 203d are depicted as being cylindrical or ring-shaped, any suitable anode

configuration may be utilized where the anode is segmented into a plurality of anode segments 203a, 203b, 203c, and 203d. For example, the anode segments may be rectangular as depicted in FIG. 6 and described below.

Please replace the paragraph at page 9, lines 4-10, with the following paragraph:

The embodiment of anode [201] <u>202</u> shown in FIG. 2 produces an electrical field whose shape can be controllably adjusted. The controllable electrical field produced by the programmable anode [201] <u>202</u> results in generation of a controllable electric current density across the seed layer on the substrate. The controller 254 controls the

the individual anode segments 203a, 203b, 203c, and 203d by controlling the electric current supplied to each individual anode segment 203a, 203b, 203c, and 203d.

Please replace the paragraph at page 10, lines 1-13, with the following

The metal ions are dissociated from within a volume of the electrolyte solution (including e.g. copper sulfate) into positively charged copper ions and negatively charged sulfate ions. The copper ions [illegible] region of the substrate [illegible] attracted to the seed layer on the substrate 48. The [illegible] of sulfate [illegible] electrolyte solution contributes to the formation of a depletion region 270 adjacent to the distinct anode segments 203a, 203b, 203c, and 203d. The dissociated metal ions are deposited on the seed layer on the substrate 48. Increasing the electrolyte solution flow from the input port 80 (and the corresponding electrolyte solution output flow over the annular weir portion 82) provides for decreasing the physical size of the depletion region 270 by replacing the depleted components. This replacing the depleted components increases the supply of copper [sulfite] <u>sulfate</u> in the electrolyte solution adjacent the seed layer. The process of dissociating metal ions from the copper [sulfite] <u>sulfate</u> continues where the dissociated metal ions may be deposited on the seed layer.

Please replace the paragraph at page 10, lines 14-30, with the following paragraph:

A reference sensor 250 is shown positioned in close proximity, but spaced from, a substrate 48 positioned for a plating operation (for example, in the contact ring [illegible]). The reference sensor 250 monitors surface potential (current density) at the plating surface 15 of the substrate 48. The reference sensor 250 is positioned as far as possible from any contact 256 supplying current/voltage to the substrate. This physical isolation of the reference sensor 250 from contacts 256 limit the electrical effects resulting from a contact that is proximally located to the reference sensor. The electric field generated in the electrolyte solution [illegible] other electrolyte solution properties are held constant, the electric field and the current density generated in the electrolyte solution is controlled by several factors including controlling the electric current flowing through the different ones of the individual anode [illegible] 203b, 203c and 203d of the anode [201] 202 as well as changing the shape and configuration of the anode. Therefore, the surface potential monitored adjacent the surface of the substrate by the reference sensor 250 provides an indication of the effect of the current flowing in the individual anode segments 203a, 203b, 203c, and 203d of the anode [201] 202.

Please replace the paragraph at page 12, lines 19-31, with the following paragraph:

The anode segment 702a can be shifted horizontally to the anode segment 702b in an alternate embodiment of programmable anode, still referring to FIG. 7. Assume that it is determined by the reference sensor 250 that the current density is not at the same level across the seed layer on a substrate during processing. One anode segment 702a or 702b is shifted to make the current density in the seed layer uniform. The relative positions of the axis 704a and 704b of the anode segment 702a or 702b can be adjusted by loosening a clamping mechanism (not shown) that secures either or

both of the anode segments 702a, 702b relatively in position. Anode segment(s) 702a or 702b [as] <u>can</u> then <u>be</u> repositioned as desired. Following repositioning of the anode segments, the clamping mechanism is reclamped to maintain the anode segments 702a and 702b in position. Additionally, the thickness of certain portions of the anode segments can be altered as shown by arrows 706a and 706b to alter the current density applied to specific locations of the seed layer on the substrate as desired.

Please replace the paragraph at page 14, lines 12-23, with the following paragraph:

voltage/current in each anode [segments] <u>segment</u> as well as the voltage/current in the contacts 256. For example, gradient current density value 806a represents when only the inner anode segment 203a shown in FIG. 2 is energized. Gradient current density value 806b represents when only anode segments 203a and 203b are energized. [illegible]

and 203c are energized. Gradient current density value 806d represents when all of the anode segments 203a, 203b, 203c, and 203d are energized. As shown in FIG. 8, as different combinations of the anode segments 203a, 203b, 203c, and 203d are energized, the instantaneous gradient current density values will vary. The gradient current density values 806a, 806b, 806c, and 806d shown in FIG. 8 are exemplary in nature, and are provided on a dimensionless scale. The total gradient current density value 808 represents the sum of the instantaneous gradient current density values 806a, 806b, 806c, and 806d for each seed layer location during the period that metal ions are being deposited across the substrate. The total gradient current density values should be substantially constant from the periphery to the center of the seed layer to ensure a uniform depth of metal deposition across the seed layer on the substrate.

Please replace the paragraph at page 14, line 29 to page 15, line 6, with the following paragraph:

The controller 254 can alter the duration and/or current level applied from each anode segment (thereby varying the instantaneous gradient current density value) to compensate for the non-uniform current density existing across the [illegible] layer. The non-uniformities exist because the [illegible] are positioned [illegible] the periphery 102 of the substrate than the center 104 of the substrate as described above. Controlling the electric current applied from the combined anode segments 203a, 203b, 203c, and 203d across the width of the programmable anode [201] 202 compensates to provide a uniform current density across the seed layer. By controlling the electric current applied through the individual anode segments 203a, 203b, 203c, and 203d, the current density near the center 104 of the seed layer on the substrate can be adjusted

Please replace the paragraph at page 16, lines 3-20, with the following paragraph:

[illegible] the controller 254 [illegible] electric voltage/current at a prescribed level to actuate the inner anode segment 203a. The method 300 then continues to step 306 where the controller 254 waits for a prescribed duration during which time the electric voltage/current applied during step 304 [illegible] applied to only the inner anode segment 203a. The application of [illegible] to the inner anode segment 203a is maintained until step 3[illegible]. When only inner anode segment 203a (and [illegible] segments 203b, 203c, and 203d) is actuated, a higher current density is applied to the center 104 of the seed layer on the substrate 48 than to the periphery 102 of the seed layer on the substrate 48. Energizing inner anode segment 203a results in the current density being higher near the center of the seed layer compared to the side of the seed layer. This higher current density results because the inner anode segment 203a is physically located closer to the center 104 of the seed layer on the substrate 48 than the periphery 102. Electrical resistance from any anode segment to the nearest seed layer is lower than the resistance to other portions of the seed layer, as described above. During the period that only the inner anode segment 203a is actuated, the rat of metal ion deposition performed within the

electropiating cell [12] 200 is higher near to the center 104 of the seed layer 15 of the substrate 48 than near the periphery 102 of the seed layer.

Please replace the paragraph at page 20, line 22 to page 21, line 4, with the following paragraph:

The reference sensors 250 may be any of the variety of sensors that [illegible] current density on the seed layer on the substrate, as described above. Since the controller 254 in this embodiment considers surface potential across the substrate, if only one reference sensor is used, then the surface potential at different locations have [illegible]

electroplating process, or quantitative measurements at certain locations [illegible] electroplating cell [12] 200 assuming that the measured values do not change. Any variation in monitored electric current values on the substrate 48, as sensed by the reference sensors 250 described above, is fed into the controller 254. The controller 254 alters the electric current applied to the anode segments 203a, 203b, 203c, and 203d to control the electric current density applied across the seed layer on the substrate. The embodiment in FIG. 4 is directed at controlling the voltage/current applied to the distinct anode segments 203a, 203b, 203c, and 203d making the sensed current density across the seed layer on the substrate substantially uniform. It is also possible to combine the teachings of the FIG. 4 embodiment with the teachings of the FIG. 3 embodiment, and thus regulating the duration that each anode segment is energized.

Please replace the paragraph at page 21, lines 5-13, with the following paragraph:

The method 400 begins with step 402 in which a substrate to be electroplated is inserted into the electroplating cell 200. The method 400 continues to step 404 in which the controller 254 applies electricity to each one of the plurality of anode segments 203a, 203b, 203c, 203d (See FIG. 2). During step 404, the current/voltage levels

applied to each one of the plurality of anode segments is initially preferably at a single voltage level. Thus, the electric field generated by the anode [201] 202 to the substrate 48 should be substantially uniform in the electrolyte solution [illegible] of the process chamber 223 in the electrolyte solution (such uniformity excludes boundary conditions adjacent the walls).

Please replace the paragraph at page 21, line 20 to page 22, line 2, with the following paragraph:

Method 400 continues to step 406 in which the controller 254 senses the [illegible]

surface potential [illegible] the surface of the [illegible] dummy [illegible] provided having sensors embedded therein such that the dummy substrate is inserted in the electroplating cell in a manner similar to an actual substrate. The anode [201] 202 is then energized, along with electric fields applied to contact points 256. Method 400 [illegible] controller 254 [illegible] in the electromagnetic field to the cathode, determines whether to adjust the electric field applied to any one of the anode segments 203a, 203b, 203c, or 203d to modify the current density across the seed layer on the substrate.

[illegible]

Applicants have proposed drawing amendments in a separate document. The proposed corrections are also shown on the attached copy of the amended drawing.

IN THE CLAIMS:

Please cancel claims 9-17, and amend the claims as follows:

2. (Amended) The anode of claim 1, wherein at least two of the plurality of anode segments [are aligned with each other relative to a plane taken perpendicular to the common segment axis] have subs[illegible]

5. (Amended) The anode of claim 1, further comprising [insulative mounts] insulating members that [position] connect adjacent segments [each one of the plurality of anode segments [relative] to each other.

7. (Amended) The anode of claim 1, wherein each one of the plurality of anode segments is [physically closest] closer to a distinct portion of the cathode than the rest

8. (Amended) The anode of claim 1, wherein at least one of the anode [segment] segments is cylindrical.